VIETNAM NATIONAL UNIVERSITY, HANOI *Date: December 24, 2014*

University of Engineering and Technology

FINAL EXAMINATION

Course: **Signals and Systems (ELT2035 4)**

Duration: 90 minutes

Part 1 (Multiple-choice questions)*: For problems in this part, you only have to give the letter of the correct answer (A/B/C/D). Explanations are not required.*

Problem 1. Which one of the following signals is an energy signal?

A. $x(t)=\sin(3\pi t)[u(t)-2u(t-4)]$

B. $x(n)=2^{-|n|}\cos(\pi n/3)$

C. $x(n)=nu(-n)$

D. $x(t)=(e^{2t}-e^{-3t})u(t)$

Answer: B

Problem 2. Which one of the following LTI systems can be both causal and stable?

A. $y(t)-\frac{dy(t)}{dt}+\frac{d^2y(t)}{dt^2}=x(t)+\frac{dx(t)}{dt}$

B. $y(n)+2y(n-1)=x(n)$

C. $\frac{dy(t)}{dt}+\frac{d^2y(t)}{dt^2}=2x(t)$

D. $8y(n)+2y(n-1)-y(n-2)=x(n-1)$

Answer: D

Problem 3. The frequency response of a continuous-time LTI system exists and is given by:

$$H(\omega)=\frac{2}{\omega^2+3j\omega-2}$$

which one of the following statements about this system is correct?

A. This system is causal.

B. This system is anti-causal.

C. This system is non-causal (not causal nor anti-causal).

D. This system is not stable.

Answer: B

Problem 4. Which one of the following statements is correct?

A. The Fourier spectrum of a discrete-time energy signal is continuous and periodic.

B. The Fourier spectrum of a discrete-time energy signal is continuous and non-periodic.

C. The Fourier spectrum of a discrete-time energy signal is discrete and periodic.

D. The Fourier spectrum of a discrete-time energy signal is discrete and non-periodic.

Answer: A

<u>Part 2 (Exercises)</u>*:For problems in this part, detailed explanations/derivations that lead to the answer must be provided.*

Problem 5. Given a causal LTI system described by the following differential equation:

$$y(t)+3\frac{dy(t)}{dt}+2\frac{d^2y(t)}{dt^2}=x(t)+2\frac{dx(t)}{dt}$$

a) Determine the impulse response of the given system.

b) Determine the initial response $y_0(t)$ of the given system to the following initial conditions: $y(0-)=-1$ and $\left.\frac{dy(t)}{dt}\right|_{t=0-}=-1$.

c) Determine the zero-state response $y_s(t)$ of the given system to the input signal $x(t)=e^{-2t}u(t)$.

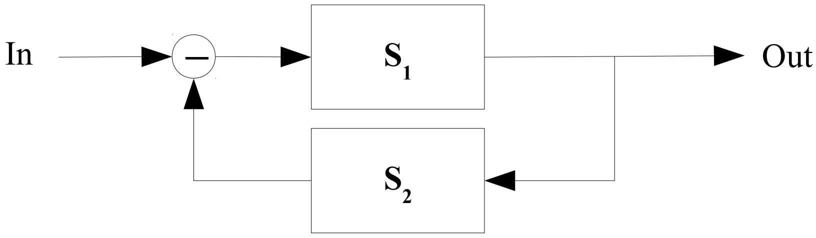
Answers:

a) Inverse Laplace transform of $H(s)=\frac{2s+1}{2s^2+3s+1}=\frac{1}{s+1}$ *(h(t) is causal).*

b) Use unilateral Laplace transform or solve the homogeneous equation with initial conditions directly.

c) Inverse Laplace transform of $Y_s(s)=H(s)X(s)$

Problem 6. Given a system **T** described by the following block diagram:



in which, $\mathbf{S_1}$ is a continuous-time linear time-invariant system described by the differential equation $y(t)+\frac{dy(t)}{dt}=\frac{dx(t)}{dt}$ and the feedback block $\mathbf{S_2}$ has the transfer function of $H_2(s)=\frac{1}{s-1}$.

a) Determine the transfer function of **T**.
b) Determine the frequency response of system **T** when: i) **T** is causal, and ii) **T** is anti-causal.
c) Determine the output of system **T** to the input $x(t)=\sin(t/3)$ when: i) **T** is causal, and ii) **T** is anti-causal.

Answers:

a) $H(s)=\frac{s(s-1)}{s^2+s-1}$

b) i) $H(\omega)=H(s)_{s=j\omega}$ *, because the system is stable; ii) not exist, because the system is not stable.*

c) i) $y(\omega)=\frac{1}{2j}H(j/3)e^{t/3}-\frac{1}{2j}H(-j/3)e^{-t/3}$ *; ii) infinity, because the frequency response does not converge at the frequency of the input sinusoidal signal.*

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