國立成功大學

115學年度碩士班招生考試試題

編　號：78

系　所：工程科學系

科　目：訊號與系統

日　期：0204

節　次：第 2 節

注　意：1.不可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

1. (20 %) Consider a system defined by the following input-output relationship:

$$y(t) = t \cdot \cos(t) \cdot x(t+2)$$

where $x(t)$ is the input and $y(t)$ is the output. Determine whether the system possesses the following properties. For each case, justify your answer clearly.
(1) Linearity? (2) Time invariance? (3) BIBO stability? (4) Causality?

2. (20 %) The impulse response of a continuous-time linear time-invariant (LTI) system is given by $h(t) = 2te^{-2t}u(t)$, and the input signal is $x(t) = u(t-1) - u(t-3)$ where $u(\cdot)$ is the unit step function. Compute the output of the system $y(t) = x(t) * h(t)$?
(Hint: * denotes the continuous-time convolution. You may express your answer as a piecewise function. Carefully consider the convolution integral limits based on the definition of $x(t)$ and $h(t)$.)

3. (20 %) Let the impulse response of an LTI system be: $h(t) = e^{2t} \cdot u(t+1)$ and the input is $x(t) = e^{-|t|}$. Find the output $h(t)$ of the system.

4. (40 %) A smart building temperature monitoring system is designed to detect gradual temperature changes in a room over time. However, it also picks up unwanted high-frequency noise from nearby electronic devices. The desired signal represents the slow-varying temperature component, while the undesired signal corresponds to the high-frequency noise. Let the desired temperature signal be $x_1(t) = \cos(10t)$, and the undesired high-frequency noise be $x_2(t) = 5\cos(10000t)$. The total input to the system is given by $x(t) = x_1(t) + x_2(t)$.
   (1) You are asked to design a linear time-invariant (LTI) system with frequency response $H(j\omega)$ such that:
   "After passing through the system, the amplitude of the high-frequency component $x_2(t)$ becomes approximately 1/200 of that of the low-frequency component $x_1(t)$ in the output signal."
   (2) Please verify mathematically that your proposed system meets the attenuation requirement.