ECE 45: Problem Set #2

Problem 2.1: In the following circuit, determine the frequency response $H(\omega) = Y/F$ and $H(0)$.

![Circuit Diagram](attachment:1.png)

Problem 2.2: A linear system with input $f(t)$ and output $y(t)$ is described by the ordinary differential equation

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 4y(t) = \frac{df}{dt}.$$ 

Determine the frequency response $H(\omega) = Y/F$ of the system.

Problem 2.3: A linear system has the frequency response

$$H(\omega) = \frac{1}{(1 + j\omega)(2 + j\omega)} \cdot \frac{A}{V}.$$ 

Determine the system steady-state output $y(t)$ with the following inputs:

(a) $f(t) = 4V$ DC

(b) $f(t) = 2\cos(2t)$ volts

(c) $f(t) = \cos(2t - (\pi/18)) + 2\sin(4t)$ volts.

Problem 2.4: In the circuit below, the input is $f(t) = 4 + \cos(2t)$, Determine the steady-state output $y(t)$ of the circuit.

![Circuit Diagram](attachment:2.png)
Problem 2.5: Given the input \( f(t) = 5 + 4e^{j2t} + 4e^{-j2t} \) and \( H(\omega) = \frac{1+j\omega}{2+j\omega} \) determine the steady-state response \( y(t) \) of the system \( H(\omega) \) and express it as a real valued signal. Hint: Use the rule \( e^{j\omega t} \rightarrow \text{LTI} \rightarrow H(\omega)e^{j\omega t} \) and superposition.

Problem 2.6: Repeat the previous problem for an input \( f(t) = 2e^{-2jt}+(2+2j)e^{-jt}+(2-2j)e^{jt}+2e^{2jt} \).

Problem 2.7: Determine whether each of the following steady-state input-output pairs is consistent with the properties of \( H(\omega) \) discussed in Section 5.2 of the Kudeki-Munson text book.

(a) \( \cos(25t) \rightarrow \text{LTI System} \rightarrow 99.5 \sin(25t - \sqrt{\pi}) \)

(b) \( 2 \cos(4t) \rightarrow \text{LTI System} \rightarrow 1 + 4 \cos(4t) \)

(c) \( 4 \rightarrow \text{LTI System} \rightarrow -8 \)

(d) \( 4 \rightarrow \text{LTI System} \rightarrow 8j \)

(e) \( 4 \rightarrow \text{LTI System} \rightarrow 4 \cos(3t) \)

(f) \( \sin(\pi t) \rightarrow \text{LTI System} \rightarrow \cos(\pi t) + 0.1 \sin(\pi t) \)

(g) \( \sin(\pi t) \rightarrow \text{LTI System} \rightarrow \cos(\pi t) + 0.1 \sin(2\pi t) \)

(h) \( \sin(\pi t) \rightarrow \text{LTI System} \rightarrow \sin^2(\pi t) \).