Name_____ ECE 3510 Homework 7   f

1. Given the conditions in Bodson, example 3.4.3, p.43,
   a) Show all the steps needed to find eq. 3.64.

$$\mathbf{H}(s) = \frac{k}{s+a}$$

$$x(t) = x_m \cdot \cos(\omega_o \cdot t) \cdot u(t)$$

b) Use the Laplace transform table to find the results in eq. 3.65 and 3.66 ($y_{ss}(t)$ part).

d) Show that equations 3.67 & 3.68 can be found from steady-state analysis of $\mathbf{H}(s)$ (see eq. 3.56).

2. Still referring to the system in example 3.4.3, p.43,   the input is: $x(t) \;=\; x_m \cdot \sin\left(\omega_o \cdot t\right)$

    a) Confirm eq. 3.70.

b) Same input, find the steady-state response in this form: $y_{ss}(t) = M \cdot x_m \cdot \cos(\omega_o \cdot t + \phi_2)$
Use any method you want.
Hint:, you may want to recall that: $\sin(\omega_o \cdot t) = \cos(\omega_o \cdot t - 90 \cdot \deg)$

3. This system: $\mathbf{H}(s) = \dfrac{3}{s+8}$ Has a cosine input: $x(t) = 4 \cdot \cos(10 \cdot t) \cdot u(t)$

a) Express the output, $\mathbf{Y}(s) =$

b) This separates into 3 partial fractions that you can find in the laplace transform table without using complex numbers. Show what they are, but don't find the coefficients.

c) Continue with the partial fraction expansion just far enough to find the **transient** coefficient as a number.

d) Express the transient part as a function of time. $y_{tr}(t) =$

e) What is the time constant of this expression? $\tau =$

f) Use steady-state AC analysis to find the steady-state output in the form of a cosine with a magnitude and phase angle.
$y_{ss}(t) = ?$

4. This system: $\mathbf{H}(s) = \dfrac{4}{s+12}$ has this cosine input: $x(t) = 5 \cdot \cos(8 \cdot t + 40 \cdot \deg) \cdot u(t)$

a) Use steady-state AC analysis to find the steady-state response ($y_{ss}(t)$) of the system. $y_{ss}(t) = ?$

b) Separate the input $x(t)$ into a pure cosine part and a pure sine part.

c) Use the results of 1b) and 2a), above to find the transient responses to cosine and sine inputs and then add them together to find the total transient response.

5. Find the steady-state (sinusoidal) magnitude and phase of the following transfer function.

$$\mathbf{H}(s) = \dfrac{\dfrac{80}{\sec}\cdot s - \dfrac{300}{\sec^2}}{s^2 + \dfrac{90}{\sec^2}}$$

$$\left|\mathbf{H}(j\cdot\omega)\right| = ? \qquad \underline{/\,\mathbf{H}(j\omega)} = ? \qquad\qquad \omega := 20\cdot\dfrac{rad}{\sec}$$

6. Express the following signal in the time domain, as a sum of cosine and sine with no phase angles:

$$\omega := 44\cdot\dfrac{rad}{\sec} \qquad \mathbf{Y}(j\omega) = 3 + 0.5\cdot j$$

7. The following questions refer to the general system whose output is given by eq. 3.81, p.45 in our text.   **hw 7 p6**

a) Can a system's response to initial conditions be calculated separately from its response to the input signal?
Why or why not?

b) Can you expect a system's response to initial conditions to be similar to its response to a simple input signal?
Why or why not?

c) To fully describe the state of the system, how many things do you need to know? List them.

d) If a system is BIBO stable, then what is its final response to initial conditions?

e) The output of a system with nonrepeated poles on the jω-axis which is otherwise BIBO stable can be unbounded for
some input signals. Is this also true for initial conditions alone when there is no input signal?
If no, why are the conditions for bounded output not as restrictive if there are only initial conditions and no input?

8. a) List 4 advantages of the state-space method over the frequency domain method we are using in this class.

b) List 2 advantages of the frequency domain method we are using in this class over the state-space method.

Answers   1 & 2a) Answers are right in the book   2.b) $\dfrac{k}{\sqrt{\omega_0^2 + a^2}}$ $-\tan^{-1}\left(\dfrac{\omega_0}{a}\right) - 90\cdot deg$

3. a) $\dfrac{3}{s+8}\cdot\dfrac{4\cdot s}{s^2+100}$ b) $\dfrac{A}{s+8} + \dfrac{B\cdot s}{\left(s^2+100\right)} + \dfrac{C\cdot 10}{\left(s^2+100\right)}$ c) -0.585 d) $-0.585\cdot e^{-8\cdot t}$ e) $125\cdot ms$
f) $0.936\cdot\cos(10\cdot t - 51.34\cdot deg)$

4. a) $1.385\cdot\cos(8\cdot t + 6.3\cdot deg)$ b) $x(t) = (3.83\cdot\cos(8\cdot t) - 3.214\cdot\sin(8\cdot t))\cdot u(t)$ c) $-1.378\cdot e^{-12\cdot t}$

5.   5.251 $-79.38\cdot deg$ 6. $3\cdot\cos\left(44\cdot\dfrac{rad}{sec}\cdot t\right) - 0.5\cdot\sin\left(44\cdot\dfrac{rad}{sec}\cdot t\right)$

7. c) 4 $y(0)$ $\dfrac{d}{dt}y(0)$ $x(0)$ $\dfrac{d}{dt}x(0)$ d) 0   8. See section 3.1 in the Nise textbook.   **ECE 3510**
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