AMERICAN UNIVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT
EECE 340 – Signals & Systems
QUIZ 2
Closed book exam
Six SHEETS OF FORMULAS WITH NO PROBLEM SOLUTIONS ARE ALLOWED
TIME: 1 HOUR and 15 minutes
May 30, 2008
INSTRUCTOR: Dr. JEAN J. SAADE

NAME : ______________________ **ID # :** ____________________

INSTRUCTIONS

- **Write your Name and ID # on this sheet, the computer card and the scratch booklet in the provided spaces.**
- **Provide your answer on the computer card and solution of each problem on the scratch booklet.**
- **Random checking will be done to find out about any inconsistency between the problem solutions on the scratch and provided answers on the computer card.**
- **Return the computer card, this question sheet and the scratch booklet when you finish the test.**
- **All questions are equally weighted in grading.**
- **Only the answers on the computer card will be considered in grading.**

PROBLEM # 1

Consider the following discrete-time sinusoidal signal:

$$x(n) = 2\cos\left(\frac{11\pi}{3}n + \frac{\pi}{4}\right)$$

Specify whether x(n) is periodic or not and if so, determine its period.

(a) Periodic with period equal to 12
(b) Periodic with period equal to 6
(c) Periodic with period equal to 3
(d) Periodic with period equal to 4
(e) x(n) is non-periodic

PROBLEM # 2

Consider again the discrete-time sinusoidal signal, x(n), as in Problem # 1. Let x(n) be present at the input of an LTI discrete-time system with impulse response given by:

$$h(n) = \left(\frac{1}{2}\right)^n u(n)$$

Determine the steady-state output, $y_s(n)$, of the system.

$(a)\ y_s(n) = \left(2/\sqrt{3}\right)\cos[(11\pi/3)n + \pi/12]$

$(b)\ y_s(n) = \left(4/\sqrt{3}\right)\cos[(11\pi/3)n + 7\pi/12]$

$(c)\ y_s(n) = \left(2/\sqrt{3}\right)\cos[(11\pi/3)n + 3\pi/4]$

$(d)\ y_s(n) = \left(4/\sqrt{3}\right)\cos[(11\pi/3)n + 5\pi/12]$

$(e)\ y_s(n) = \left(1/\sqrt{3}\right)\cos[(11\pi/3)n + 11\pi/12]$

PROBLEM # 3

Consider the following linear and time-varying discrete-time system:

$$y(n) = T[x(n)] = a^n\ x(n)$$

Let the system input, x(n), be given by

$$x(n) = b^n\ u(n)$$

Determine the output, y(n), of the system.

$(a)\ y(n) = (a/b)^n u(n)$

$(b)\ y(n) = (ab)^n u(n)$

$(c)\ y(n) = (b/a)^n u(n)$

$(d)\ y(n) = (a)^n u(n)$

$(e)\ y(n) = (b)^n u(n)$

PROBLEM # 4

Consider again Problem # 3. Determine first the impulse response, h(n), of the considered system. Then, perform the convolution of the system input $x(n)=b^n u(n)$ with h(n). Obtain the result of this convolution; i.e., $y_c(n)=x(n)*h(n)$.

$(a)\ y_c(n) = b^n u(n)$

$(b)\ y_c(n) = a^n u(n)$

$(c)\ y_c(n) = (ab)^n u(n)$

$(d)\ y_c(n) = (a/b)^n u(n)$

$(e)\ y_c(n) = (b/a)^n u(n)$

PROBLEM # 5

Consider the following transfer function, H(s), of a causal and stable analog system:

$$H(s)=\frac{s-1}{(s+2)(s+5)}$$

Use the method of impulse invariance; i.e., h(n)=h(t) at t=n, and determine the transfer function, H(z), of the causal and stable discrete-time system. Use $a=e^{-2}$ and $b=e^{-5}$.

$$(a)\ H(z)=\frac{z^2-(2a-b)z}{(z-a)(z-b)} \qquad (b)\ H(z)=\frac{z^2-(2a+b)z}{(z-a)(z+b)}$$

$$(c)\ H(z)=\frac{z^2-(2a-b)z}{(z+a)(z-b)} \qquad (d)\ H(z)=\frac{z^2-(2a+b)z}{(z+a)(z+b)}$$

$$(e)\ H(z)=\frac{z^2+(2a+b)z}{(z-a)(z-b)}$$

PROBLEM # 6

Determine the Z-transform, X(z), of the sequence x(n), as given below, and specify the region of convergence of X(z).

$$x(n)=a^{n-1}u(n-1)+b^{n-2}u(n-2)$$

$$(a)\ X(z)=\frac{z^2+z(b-1)-a}{z(z-a)(z-b)},\ |z|>\max(|a|,|b|)$$

$$(b)\ X(z)=\frac{z^2-z(b-1)-a}{z(z-a)(z-b)},\ |z|<\min(|a|,|b|)$$

$$(c)\ X(z)=\frac{z^2-z(b-1)-a}{z(z-a)(z-b)},\ |z|>\max(|a|,|b|)$$

$$(d)\ X(z)=\frac{z^2+z(b-1)-a}{z(z-a)(z-b)},\ |z|<\min(|a|,|b|)$$

$$(e)\ X(z)=\frac{z^2+z(b-1)-a}{z(z-a)(z-b)},\ |z|>(|a|+|b|)$$

PROBLEM # 7

Consider the following sequence:

$$x(n)=a^{n-1}u(n-1)$$

Let x(n) be present at the input of an LTI discrete-time system with impulse response given by:

$$h(n)=a^{n}\ u(n)$$

Determine the output, y(n), of the system. You may use the convolution or Z-transform method, whichever is easier for you.

$(a)\ y(n)=(n+1)a^{n-1}u(n-1)$ $(b)\ y(n)=(n+1)a^{n+1}u(n-1)$

$(c)\ y(n)=na^{n+1}u(n-1)$ $(d)\ y(n)=na^{n-1}u(n-1)$

$(e)\ y(n)=(n-1)a^{n-1}u(n-1)$

PROBLEM # 8

Consider a discrete-time LTI system with impulse response, h(n), given by:

$$h(n)=(a^n+b^n)\,u(n)$$

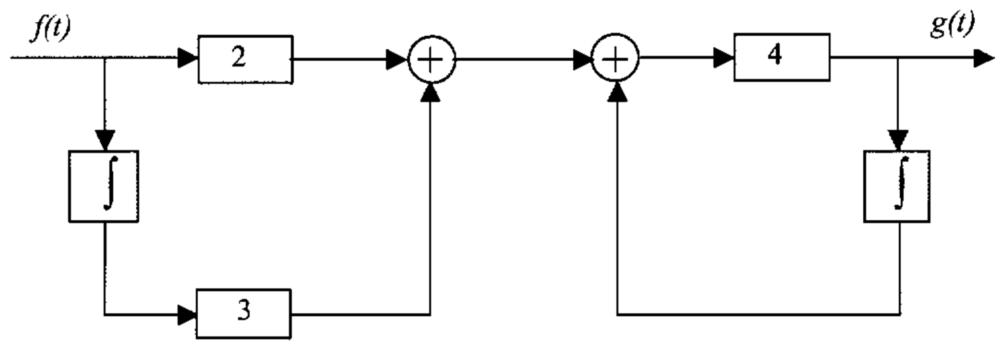
Determine the condition under which the system is stable.

$(a)\ \max(|a|,|b|)>1$ $(b)\ \max(|a|,|b|)<1$ $(c)\ \min(|a|,|b|)<1$

$(d)\ \min(|a|,|b|)>1$ $(e)\ |a|<1 \text{ or } |b|<1$

PROBLEM # 9

Consider the block diagram shown in the figure below and representing an LTI analog system. Determine the system differential equation.



$(a)\ \frac{dg(t)}{dt}-\frac{1}{4}g(t)=8\frac{df(t)}{dt}+12f(t)$ $(b)\ \frac{dg(t)}{dt}+4g(t)=2\frac{df(t)}{dt}+3f(t)$

$(c)\ \frac{dg(t)}{dt}-4g(t)=8\frac{df(t)}{dt}+12f(t)$ $(d)\ \frac{dg(t)}{dt}-\frac{1}{4}g(t)=2\frac{df(t)}{dt}+3f(t)$

$(e)\ \frac{dg(t)}{dt}-4g(t)=\frac{1}{2}\frac{df(t)}{dt}+\frac{1}{3}f(t)$

PROBLEM # 10

Consider again the block diagram in Problem # 9. Obtain the system transfer function, H(s), and tell if the system is or is not stable. Note that H(s) can be obtained directly from the block diagram without using the system differential equation.

$(a)\ H(s) = \dfrac{2s+3}{(s-1/4)}$; unstable

$(b)\ H(s) = \dfrac{2s+3}{(s+4)}$; stable

$(c)\ H(s) = \dfrac{(1/2)s+1/3}{(s-4)}$; stable

$(d)\ H(s) = \dfrac{8s+12}{(s-1/4)}$; unstable

$(e)\ H(s) = \dfrac{8s+12}{(s-4)}$; unstable