AMERICAN UNIVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT
EECE 440 – Signals & Systems
QUIZ 1
Closed book exam
Three SHEETS OF FORMULAS WITH NO PROBLEM SOLUTIONS ARE ALLOWED
TIME: 1 HOUR and 15 minutes
April 4, 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.**

PROBLEM # 1

Consider the following continuous-time signal:

$$f(t) = e^t u(t)$$

Determine the nature of this signal.

(a) Neither energy nor power signal.
(b) Energy signal.
(c) Power signal
(d) Periodic signal.

PROBLEM # 2

Consider a causal LTI system with impulse response given by:

$$h(t) = e^{t}u(t)$$

Let the input to the system be given by $f(t) = e^{-2t}u(t)$. Obtain first the output, g(t), of the system using either convolution or Laplace transform method. Then, consider g(t) and determine its nature.

(a) Power signal.
(b) Energy signal.
(c) Neither energy nor power signal
(d) Periodic signal.

PROBLEM # 3

Consider again Problem # 2 with the only difference that the system impulse is now given by

$$h(t) = e^{-t}u(t)$$

Obtain first the output, g(t), of the system using either convolution or Laplace transform method. Then, consider g(t) and determine its nature.

(a) Power signal.
(b) Energy signal
(c) Neither energy nor power signal
(d) Periodic signal.

PROBLEM # 4

Consider the following system:

$$g(t) = T[f(t)] = 4\int_{-\infty}^{t} f(\tau)d\tau + u(t)$$

Examine the linearity, causality and time-invariance of the system and then select from what is given below the correct answer.

(a) Non-linear, causal and time-invariant
(b) Non-linear, causal and time-varying
(c) Non-linear, non-causal and time-varying
(d) Linear, causal and time-invariant
(e) Linear, causal and time-varying

PROBLEM # 5

The sampling of a low-pass signal which is not strictly band-limited produces what is called aliasing effect in the spectrum of the sampled signal. To reduce this effect and, thus, be able to retrieve the closest possible signal to the original low pass one by ideal low-pass filtering, two possible techniques might be considered. 1) Band-limit the signal before sampling by low-pass filtering and then sample at a rate bigger than or equal to the Nyquist rate. 2) Sample at a rate which is much larger than the Nyquist rate.

Assume that the LPFs used in both techniques for retrieval and also in technique 1 for band-limiting are ideal and have the same bandwidth. Based on this assumption, determine which technique is preferred in the sense of leading to the retrieval of a signal closest to the original low-pass one.

(a) Technique 2 is preferred
(b) Technique 1 is preferred
(c) Both techniques are equivalent
(d) No technique is desirable or preferred since they are both bad.
(e) There must be a better technique which needs to be invented.

PROBLEM # 6

Consider the asynchronous detection of the following received DSB-SC signal:

$$s_r(t) = A_r f(t)\cos(\omega_c t - \phi_1)$$

The received signal is multiplied by $c(t) = A_c \cos(\omega_c t - \phi_2)$ and then the output of the multiplier is inputed to an ideal low-pass filter. Determine the value(s) of the difference $(\phi_1 - \phi_2)$ which lead to the absence of signal at the output of the LPF.

(a) $(\phi_1 - \phi_2) = (k+1)\pi/2,\ k = 0, \pm 1, \pm 2, \ldots.$
(b) $(\phi_1 - \phi_2) = k\pi,\ k = 0, \pm 1, \pm 2, \ldots.$
(c) $(\phi_1 - \phi_2) = (2k+1)\pi/2,\ k = 0, \pm 1, \pm 2, \ldots.$
(d) $(\phi_1 - \phi_2) = 2k\pi,\ k = 0, \pm 1, \pm 2, \ldots.$
(e) $(\phi_1 - \phi_2) = k\pi/2,\ k = 0, \pm 1, \pm 2, \ldots.$

PROBLEM # 7

Consider again the received DSB-SC signal in Problem # 6. Let ϕ_1 be the phase shift of the received signal due to time delay representing the travel-time between the transmitter and receiver. Assume that $\phi_1 = 200\pi$ rad and determine the signal travel-time if the DSB-SC signal carrier frequency is equal to 1000 KHz.

(a) 0.1 ms (b) 0.1 μs (c) 0.01ms (d) 0.01 μs (e) 0.001ms

PROBLEM # 8

Consider the following signal:

$$f(t) = rect\left(\frac{t-2\times10^{-5}}{4\times10^{-5}}\right)$$

Let f(t) be sampled at the rate of 50,000 samples/s to obtain the discrete-time signal f(n). Determine magnitude of the Fourier transform of f(n); i.e., $|F(\omega)|$.

$(a)\ |F(\omega)| = \left|\frac{\sin(\omega T/2)}{\sin(\omega T)}\right|$ $(b)\ |F(\omega)| = \left|\frac{\cos(\omega T/2)}{\sin(\omega T)}\right|$

$(c)\ |F(\omega)| = \left|\frac{\cos(3\omega T/2)}{\cos(\omega T/2}\right|$ $(d)\ |F(\omega)| = \left|\frac{\sin(\omega T/2)}{\cos(\omega T)}\right|$

$(e)\ |F(\omega)| = \left|\frac{\sin(3\omega T/2)}{\sin(\omega T/2)}\right|$

PROBLEM # 9

Consider a LTI system with impulse response given by

$$h(t) = e^{(j\omega_c - 2)t}u(t)$$

The transfer function of this system has a single pole. Determine this pole.

$(a)\ s = -4 + j2\omega_c$ $(b)\ s = -2 + j\omega_c$ $(c)\ s = 2 + j\omega_c$

$(d)\ s = 2 - j\omega_c$ $(e)\ s = -2 - j\omega_c$

PROBLEM # 10

Consider a LTI system with impulse response given by

$$h(t) = 4e^{-2t}\cos(\omega_c t)u(t)$$

Obtain first the transfer function, H(s), of this system and then determine the poles of H(s).

$(a)\ s_{1,2} = -4 \pm j2\omega_c$ $(b)\ s_{1,2} = 2 \pm j\omega_c$ $(c)\ s_{1,2} = 4 \pm j2\omega_c$

$(d)\ s_{1,2} = -2 \pm j\omega_c$ $(e)\ s_{1,2} = -1 \pm j\omega_c$

PROBLEM # 11

Consider a LTI system with impulse response given by

$$h(t) = \begin{cases} 4e^{-2t}\cos(\omega_c t), t > 0 \\ 4e^{2t}\cos(\omega_c t), t < 0 \end{cases}$$

Determine the region of convergence of the transfer function of the system and then conclude if the system is stable or not.

(a) $2 < \sigma < 4$; unstable

(b) $-2 < \sigma < 2$; stable

(c) $-4 < \sigma < 4$; stable

(d) $-1 < \sigma < 1$; stable

(e) $-4 < \sigma < -2$; unstable

PROBLEM # 12

Consider a LTI system with transfer function given by

$$H(s) = \frac{2}{(s+4)(s+2)}$$

Determine the impulse response, h(t), of the system considered to be unstable, non-causal and such that h(t)=0 for t>0.

(a) $h(t) = (e^{-2t} - e^{-4t})u(-t+2)$

(b) $h(t) = (e^{-2t} - e^{-4t})u(-t)$

(c) $h(t) = (e^{-4t} - e^{-2t})u(-t-2)$

(d) $h(t) = (e^{-2t} - e^{-4t})u(-t-4)$

(e) $h(t) = (e^{-4t} - e^{-2t})u(-t)$