EE 322/522 **Summer '99**

MID-TERM 1

1 hr. 15 min. *7th* July, 1999

The exam will be graded out of 25 points. You may earn **BONUS** points by submitting the computer code (see below for further details).

1. (a) The unit sample response of a system is given by, $h(n) = a^n u(n-3)$ with $a = 1.0001$. Is the system stable? Explain your answer. If your answer happens to be 'NO', what should be the range of a for such a system to be stable?
   (b) Given the input/output relationship of the following discrete system :

$$y(n) = 30n^2x^2(n+1).$$

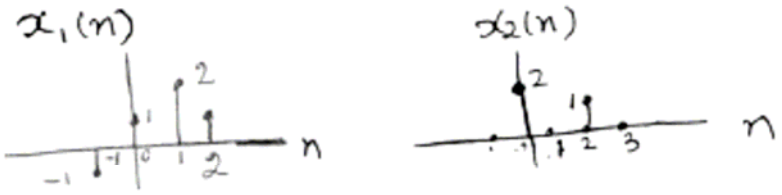
   Find out whether the system is (i) Causal, (ii) Linear (iii) Stable and (iv) Time-Invariant. Please justify your answers mathematically.
   (c) For the input/output relationship of part-(b), find and plot the output $y(n)$ for $n = 0, 1, 2, 3, 4$, if the input signal is, $x(n) = nu(n-1)$. (5 pts.)

2. (a) Two signals $x_1(t) = 5\sin 200\sqrt{2}\pi t$ and $x_2(t) = 8\cos 400\pi t$ are both sampled with sampling frequency $f_s = 250Hz$. Find the individual discrete sequences $x_1(nT)$ and $x_2(nT)$.
   (i) Are the discrete signals periodic? Find the period/s.
   (ii) If a signal is formed as $x(t) = x_1(t) + x_2(t)$, and sampled according to the suggested sampling frequency, will there be any aliasing? Explain.
   (b) Repeat all questions in part (a) with $f_s = 500\sqrt{2}Hz$.
   (c) What are the appropriate Nyquist rates for $x_1(t)$, $x_2(t)$ and $x(t)$. (3 pts.)

3. Given the unit sample response of an interconnected system, $h(n) = h_3(n) + [h_5(n) * (h_1(n) * (h_2(n) - h_4(n))) * h_6(n)]$, sketch the block diagram of the system in terms of the blocks of $h_1(n), \ldots, h_6(n)$. (2 pts.)

4. Convolve the following pairs of discrete sequences (6 pts.)

(i) Graphical or Tabular convolution between,



(ii) Analytical convolution between,

$x_1(n) = 2[u(n-1) - u(n-7)]$ and $x_2(n) = \frac{1}{2}^n u(n)$

5. A discrete-time system is described by the difference equation: $y(n) = 0.2y(n-1) + 2x(n) - 4x(n-1)$.

(a) Find an analytical expression for the initial condition response (*i.e.*, solution of homogeneous equation) of the system if $y(-1) = -1$. Is this system stable?

(b) Find an analytical expression for the forced response ($y_p(n)$) of the system if the input, $x(n) = (n+1)u(n)$.

(c) For the same input as in part-b, find an analytical expression for the total response ($y_T(n)$) of the system if $y(-1) = 0$. (9 pts.)

Total Points 25