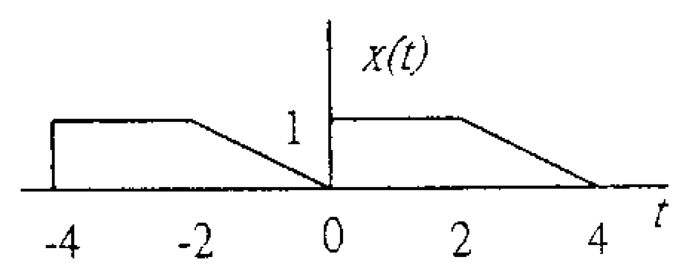
科目：訊號與系統(300C)　　　　校系所組：中央大學電機工程學系（電子組）
交通大學生醫工程研究所(乙組)
清華大學電機工程學系（乙組）

1. For signal *x(t)* depicted below, sketch and label carefully each of the following signals.

   (a) $x\left(\frac{t}{2}-2\right)$ **(2%)**

   (b) even signal of *x(t)* **(3%)**



2. Consider an LTI system with input and output related through the equation $y(t)=\int_{-\infty}^{t} e^{-(t-\tau)}x(\tau-1)d\tau$

   Find the impulse response *h(t)* for this system. **(5%)**

3. Consider the LTI system initially at rest and described by the difference equation

$$y[n]+2y[n-1]=x[n]+2x[n-2]$$

   Find the response of this system to the input $x[n]=\delta[n+2]+2\delta[n+1]+3\delta[n]+2\delta[n-1]+2\delta[n-2]$ **(5%)**

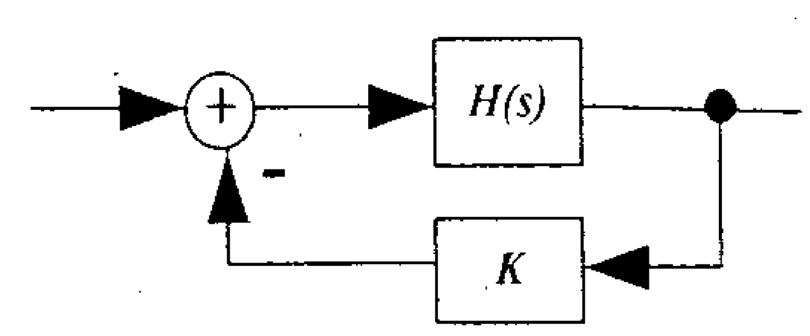
4. $X(s)=\frac{2s-1}{s^3-s}$, determine

   (a) *x(t)* **(5%)**

   (b) the initial and final values of *x(t)*. **(5%)**

5. Consider a feedback system shown below, where $H(s)=\frac{s+2}{s^2+2s+4}$

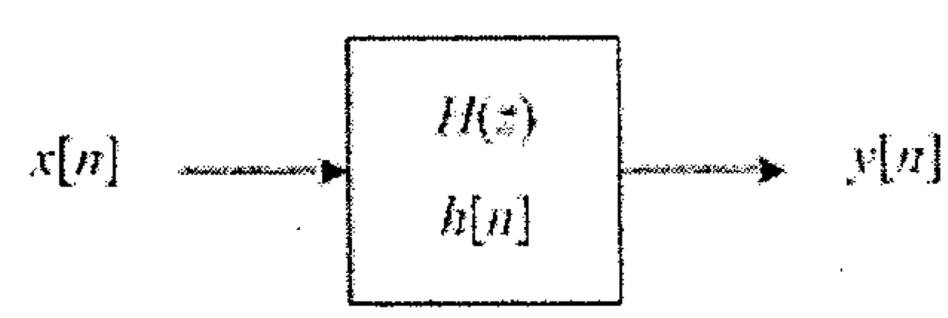
   (a) Find the smallest positive value of *K* for which the closed-loop impulse response doesn't exhibit any oscillatory behavior. **(5%)**



   (b) Find the value of *K* for which the phase margin is $\frac{\pi}{3}$. **(5%)**

   (c) Find the value of *K* for which the closed-loop damping factor is $\frac{1}{\sqrt{2}}$. **(5%)**

6. Consider the following system.



   (a) Let $H(z)=\frac{1-\frac{2}{9}z^{-1}}{1-\frac{1}{3}z^{-1}}$ and $x[n]=(\frac{1}{6})^n u[n]$, where $u[n]$ is the unit step function with unity gain for $n\geq 0$. If Region of Convergence (ROC) of $y[n]$ is a ring, determine the output $y[n]$. **(5%)**

   (b) Let $H(z)=\frac{1-2\sqrt{2}z^{-1}}{1-\frac{\sqrt{2}}{3}z^{-1}}$ and $x[n]=\frac{1}{6}[sin\Omega_0 n]u[n]$ for $\Omega_0=\frac{\pi}{4}$. If ROC of $y[n]$ exists, determine the output $y[n]$? **(10%)**

7. Let $x(t)=\cos(4\pi f_2 t)e^{j2\pi f_1 t}$ and $f_2>f_1>0$.

   (a) What is the criterion for sampling frequency f_s (Nyquist frequency)? **(3%)**

   (b) If $y(t)=\left(x(t)\right)^2$, what is the criterion for sampling frequency f_s (Nyquist frequency)? **(3%)**

   (c) If $y_p(t)=y(t)p(t)$ and $p(t)=\sum_{n=-\infty}^{+\infty}\delta(t-\frac{n}{12f_2})$, please depict the spectrum $Y_p(\omega)$ of $y_p(t)$ with y-axis indicating the magnitude of $|Y_p(\omega)|$. **(5%)**

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(d) If an ideal low-pass filter with cutoff frequency ω_c is used to interpolate $y_p(t)$ for reconstructing $y(t)$, what is the requirement for ω_c without generating the aliasing effect? **(4%)**

8. Suppose that a continuous-time periodic signal x(t) is the input to an LTI system. The signal has a Fourier series representation: $x(t)=\sum_{k=-\infty}^{\infty}\alpha^{|k|}e^{jk(\pi/4)t}$, where α is a real number and 0 < α < 1, and the frequency response of the system is

$$H(jw)=\begin{cases}1, & |w|\le W\\ 0, & |w|>W\end{cases}.$$

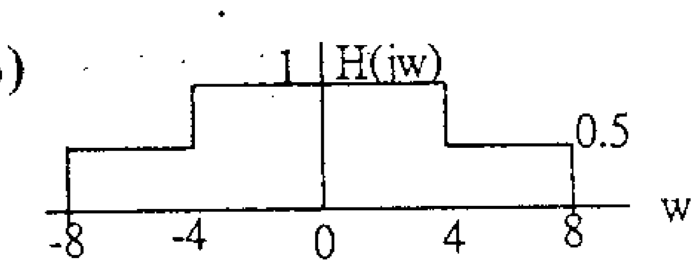
(a) The fundamental period of x(t) = __________. **(2%)**

(b) The average energy per period of x(t) = __________. **(3%)** (express the average energy per period in terms of α)

(c) For the output of the system to have at least 90% of the average energy per period of x(t), the frequency W = __________. **(5%)** (express W in terms of α)

You need to write down your answers only. No partial scores for your computation procedures.

9. Consider a continuous-time system with frequency response H(jw) shown below.



(a) The energy of the impulse response h(t) of the system = __________. **(3%)**

(b) When the input of the system is given by x(t) = 2(cos2t)(sin7t), the output y(t) = __________. **(3%)**

(c) When the input is an impulse train given by $x(t)=\sum_{k=-\infty}^{\infty}\delta(t-k-1)$, the output y(t) **computed by first finding out Y(jw)=H(jw)X(jw) then obtaining y(t) from Y(jw) =** __________. **(4%)**

(Note: Direct convolution of x(t) and h(t) to obtain y(t) will get no credit.)

You need to write down your answers only. No partial scores for your computation procedures.

10. When the impulse train $x[n]=\sum_{k=-\infty}^{\infty}\delta[n-4k-1]$ is the input to a particular LTI system with frequency response $H(e^{jw})$, the output of the system is found to be $y[n]=\cos(\frac{5\pi}{2}n+\frac{\pi}{4})$.

(a) The value of $H(e^{j0})$ = __________. **(3%)**

(b) $\sum_{k=0}^{3}H(e^{jk\pi/2})$ = __________. **(7%)**

You need to write down your answers only. No partial scores for your computation procedures.

注：背面有試題