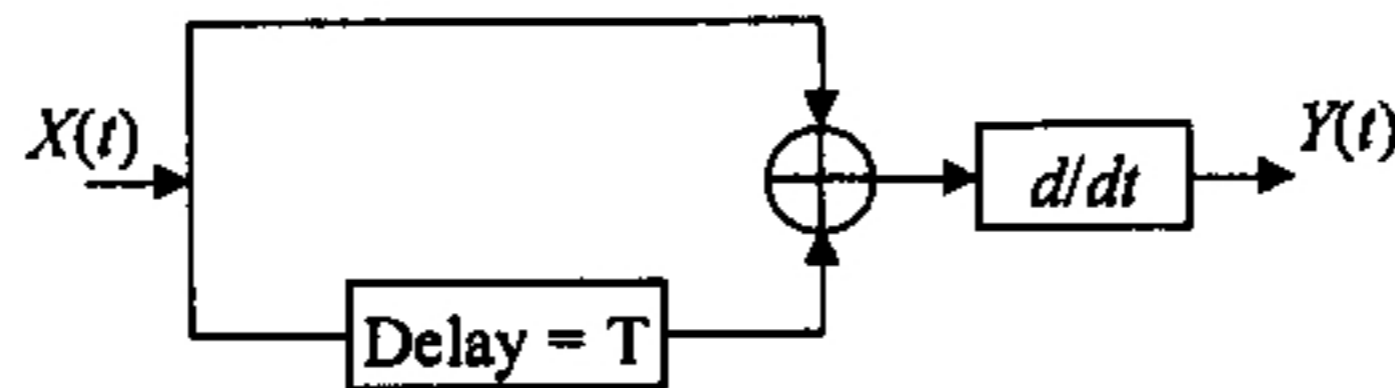1. (20 points) Use Parserval段theorem, determine the value of the integral

$$\int_{-\infty}^{\infty} \frac{(\sin \pi f)^3}{f^3}$$

and determine the the Fourier transform of $x(t) = e^{-\alpha |t|}$, where $\alpha > 0$.

2. (30 points) $X(t)$ is a stationary process with power-spectral density $S_X(f)$. This process passes through the system shown in the following figure.

   A. (10 points) Is $Y(t)$ stationary? Why?
   B. (10 points) What is the power-spectral density of $Y(t)$?
   C. (10 points) What frequency components can not be present in the output process and why?

3. (20 points) Suppose that the message signal is given as

$$m(t) = 10 + 4\cos 2\pi t + 8\cos 4\pi t + 10\cos 20\pi t$$

   Please specify the frequency-response characteristic of a VSB filter that passes the upper sideband and the first frequency component of the lower sideband

4. (30 points) Three messages are

$$s_1(t) = \begin{cases} 0 & 0 \le t \le T \\ 1 & otherwise \end{cases}, s_2(t) = -s_3(t) = \begin{cases} 1 & 0 \le t \le \frac{T}{2} \\ -1 & \frac{T}{2} \le t \le T \\ 0 & otherwise \end{cases}$$

   A. (10 points) What is the dimensionality of the signal space?
   B. (10 points) Find an appropriate basis for the signal space.
   C. (10 points) Draw the signal constellation for this problem.