Major Test
Communication Engineering (EEL306)

Time : 2 hours Max Marks : 40

1. As discussed in the class, stereophonic FM broadcasting is accomplished by using DSB modulation for multiplexing and FM modulation for transmission. In the system illustrated in Fig. 1, L(t) and R(t) are the left and right signals, bandlimited to 15kHz each.

   (a) Sketch the spectrum of the baseband signal $x_b(t)$ at the FM modulator, input **(3)**

   (b) Design a system for demodulating the stereophonic signal. **(4)**

   (c) The FM system uses a deviation ratio of 5. Compare the required transmission bandwidth of a stereophonic FM signal to non-stereophonic FM signal. **(3)**

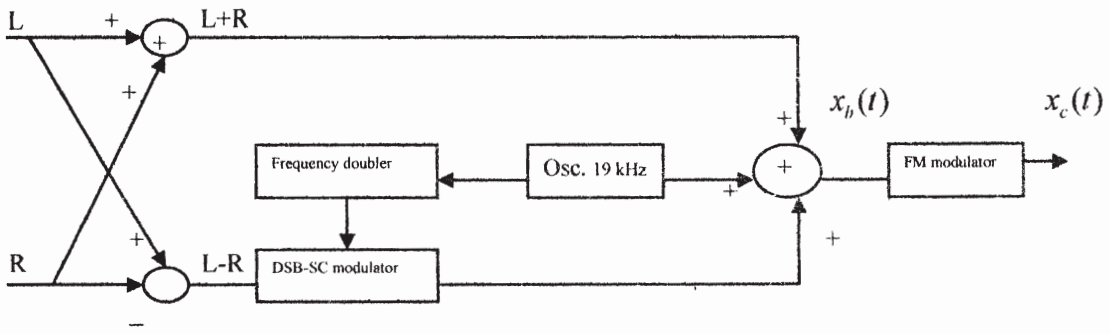

Fig. 1

2. In the stereophonic broadcasting system of Problem 1,

   (a) Compare the noise powers at the receiver outputs corresponding to the $L(t)+R(t)$ and $L(t)-R(t)$ channels. Is stereophonic broadcasting more sensitive to noise than non-stereophonic broadcasting? If so, how much more? **(7)**

   (b) What changes, if any, would you suggest to make stereophonic transmission less sensitive to noise? **(3)**

   Assume that the channel noise has a power spectral density of $\frac{N}{2}$, the carrier amplitude is A_c and the demodulator constant is k_d

3. A noise waveform $n_1(t)$ has the bandlimited power spectral density $S_{n1}(f)$ shown in Fig. 2. Find and plot the power spectral density of $n_2(t) = n_1(t)\cos(\omega_o t + \theta) - n_1(t)\sin(\omega_o t + \theta)$, where θ is a uniformly distributed random variable in $(0, 2\pi)$. **(7)**

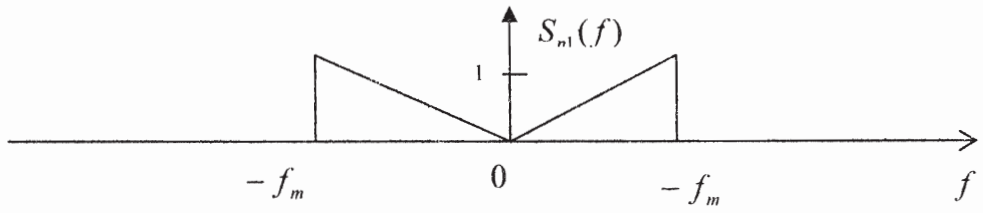

Fig. 2

4. An ideal finite-time integrator is characterized by the input-output relationship

$$Y(t) = \frac{1}{T}\int_{t-T}^{t} X(\alpha)d\alpha$$

(a) What is its impulse response and transfer function? **(3)**

(b) If the input to the system is white noise with two-sided power spectral density $\frac{N}{2}$, find the auto-correlation function and power spectral density of the output of the filter. **(4)**

5. Consider a chain of (n-1) regenerative repeaters, with a total of n sequential decisions (regarding transmission of a 1 or 0) made on a binary PCM wave, including the final decision made at the destination receiver. Assume that any binary symbol transmitted through the system has an independent probability p_1 of being inverted (i.e. detected erroneously) by any repeater. Let p_n represent the probability that a binary symbol is in error after transmission through the complete system.

(a) Find an expression for p_n in terms of p_1, assuming 1's and 0's to be equally likely. **(4)**

(b) If p_1 is very small and n is not too large, what is the approximate value of p_n? **(2)**